Harmful Algae in the Chesapeake and Coastal Bays of MD and VA

Alexandrium monilatum

This chain forming, fish killing dinoflagellate blooms during late summer in the lower York River and James River estuaries leading to mass die offs of cultured Rapa whelk populations. It was first seen in 2007 and has been documented nearly every year since. As a cyst former, recurrent blooms are likely into the future, dominating summer productivity and surface organic matter. Dense surface accumulations, rich in chlorophyll are detectable using remote sensing.

Aureococcus anophagefferens

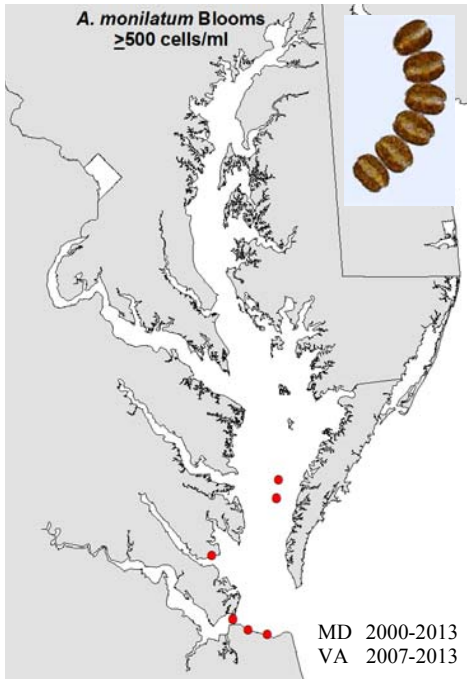
This 2 µm pelagophyte produces dense 'brown tide' blooms that peak in May-mid July. Common along the Atlantic seaboard generally in long residence time high salinity lagoon systems. Populations reach sufficient densities to shade underlying submersed grasses, and remain largely ungrazed within the water column. In embayments on Long Island, NY, this organism caused collapse of the scallop fishery. This algae contains unique pigments and due to its small size and dense accumulations should be detectable remotely.

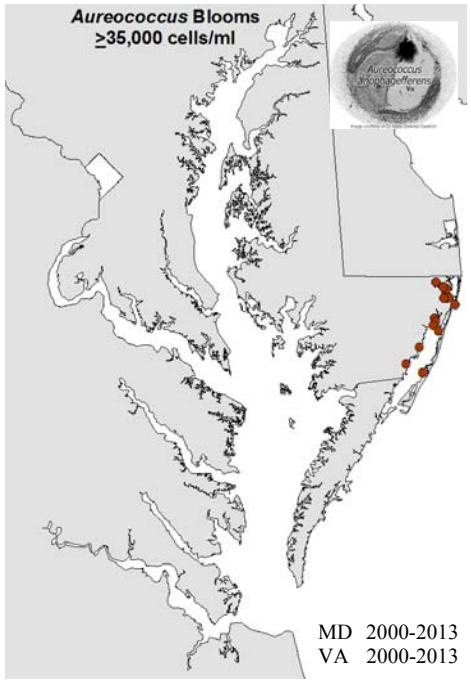
Cochlodinium polykrikoides

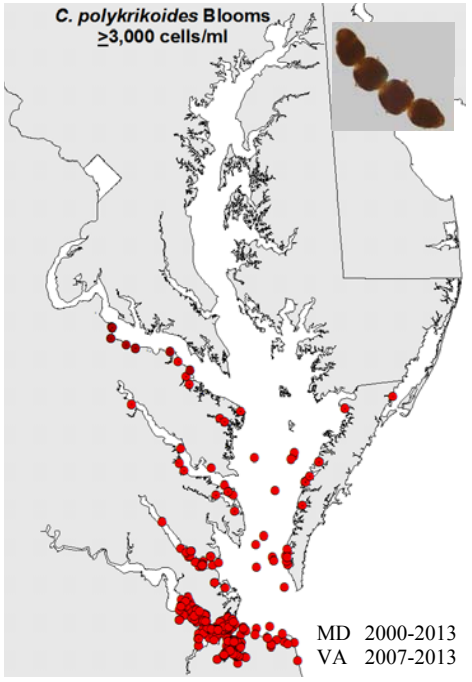
This large (30-40 µm x 20-30 µm) chlorophyll-containing, unarmored dinoflagellate is found globally, forming small to many celled chains. In the Bay, it arises from cyst beds following summer rain events (mid to late July), and expands through division and transport to cover much of the lower James and York Rivers. These 'mahogany-tide' blooms are harmful to early life stages of fish and shellfish but not people and should be detectable with remote sensing.

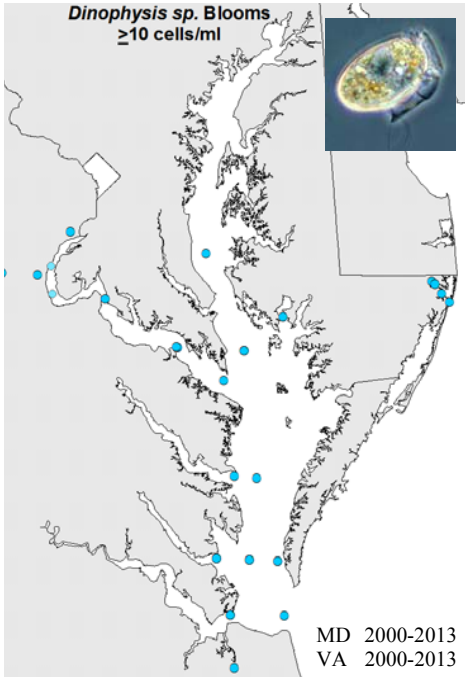
Dinophysis spp.

This is a coastal ocean dinoflagellate that can contain some to no pigments. *Dinophysis* produces okadaic acid as well as other toxins that lead to diarrhetic shellfish poisoning, DSP. Primarily blooms subsurface in thin layers. Only occasionally seen in the Chesapeake, it often blooms in the MD coastal bays (blooms Jan-June). In 2002, the lower Potomac had a temporary closure of oyster harvests. Its delivery up-bay is tied to presence in coastal waters as well as drought conditions. At bloom levels (10 cells/ml), it is still scarce and likely not detected with remote detection.









Karlodinium veneficum

This is a small (9-18 µm x 7-14 µm) chlorophyll-containing dinoflagellate common to the Bay and its tributaries producing ichthyotoxins named karlotoxins. Known as the 'fish-killer,' the toxins now number 5 varieties and are toxic or allelopathic to most taxa containing cholesterol, i.e., phytoplankton, protozoa, and metazoans. The taxon is generally a spring-to-fall species. It is autotrophic and mixotrophic with faster growth rates when feeding on prey, often cryptophytes. It is detectable using remote sensing.

Microcystis aeruginosa

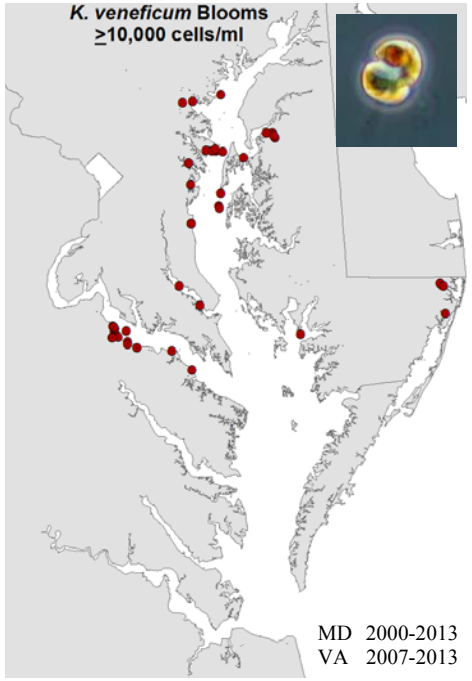
This is a fresh to brackish cyanobacterium (2-3 µm sphere), that is a global problem as high biomass or toxic blooms. Single small cells rich in chlorophyll and phycobilin accessory pigments which form large, visible scums on the surface. This species can produce liver toxins (microcystins) and neurotoxins. Populations exhibit daily vertical movement, rising to the surface in the early day from gas-filled vesicles and descending in late afternoon. Populations are poorly grazed. It is a summer bloomer that can be detected remotely using the Great Lakes cyano-index.

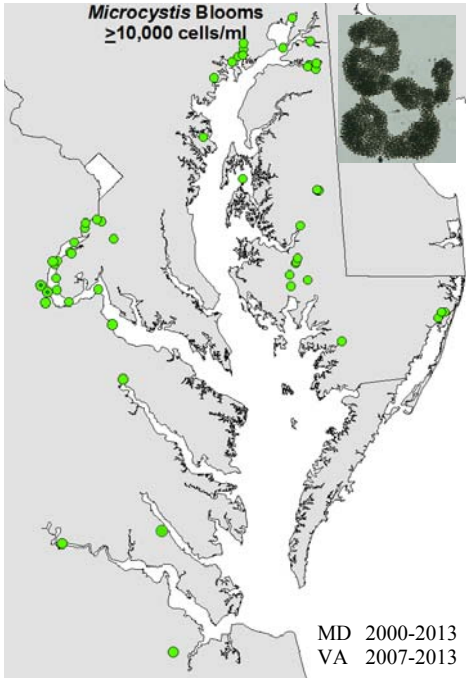
Prorocentrum minimum

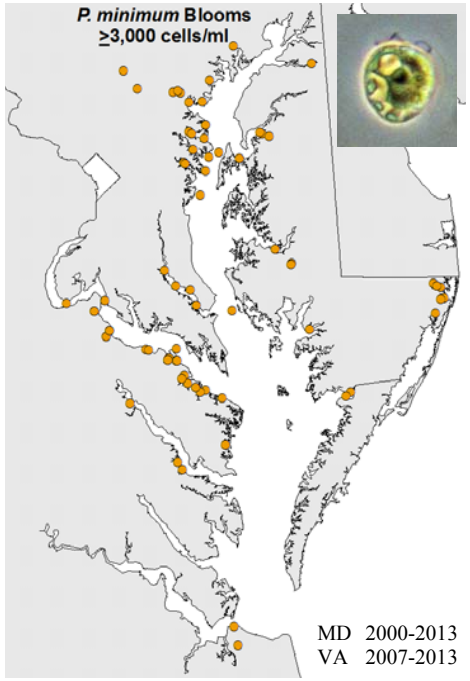
Blooms of this chlorophyll-rich dinoflagellate (14-22 µm x 10-15 µm) are called 'mahogany tides' and are a normal constituent of the late spring, post-diatom bloom community. They are transported throughout the bay at or near the pycnocline during the winter-early spring, followed by mixing into surface waters in May. Some non-U.S. strains are toxic to shellfish, but most often *P. minimum* is regarded as benign in bay. However, it does contribute to low oxygen and the dead zone. Should be easily detected as an increase in chlorophyll.

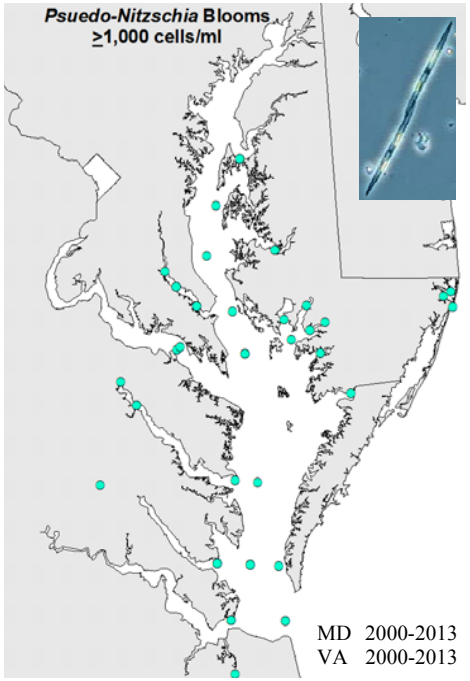
Pseudo-nitzschia spp.

This genus contains chlorophyll-bearing pennate (long & narrow) diatoms that can produce domoic acid a neurotoxin that causes amnesic shellfish poisoning, ASP, in Canada, CA, LA, and the Northwest, and then most other continents. Several *Pseudo-nitzschia* species have been identified in CB in cooler months, but densities are very low and domoic acid production is low to undetectable. Hence, the genus does not pose a threat to human health or other fauna at this time. The very low densities would prevent detection using remote sensing.









Compiled by: Todd Egerton (Old Dominion University), Margaret Mulholland (Old Dominion University), Kevin Sellner (Chesapeake Research Consortium), and Catherine Wazniak (Maryland Department of Natural Resources)

Harmful Algae in the Chesapeake and Coastal Bays of MD and VA (cont.)

Raphidophytes (*Chattonella, Fibrocapsa, Heterosigma*)

Delaware's coastal bays and a portion of Maryland's are frequented by several raphidophyte species (~10 µm biflagellated cells) that can yield fish mortalities or low dissolved oxygen events. These are usually observed in upper tributaries or the small nutrient-rich, long-residence time canals of the coastal bays, often summarized by Delaware's Citizen Monitoring Program (http://citizen-monitoring.udel.edu/).

Raphidophytes are pigment rich making remote sensing possible. However, the small size of the canals may result in insufficient pixel resolution in the satellite images, at least until the cells are transported into the larger, open bays.

Chattonella

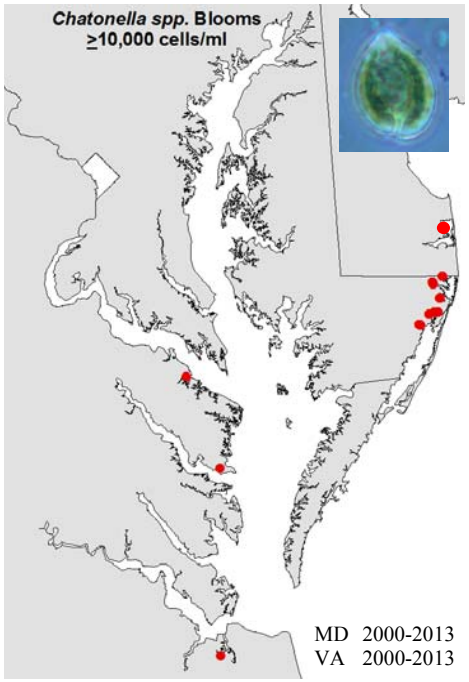
Chattonella cf. *verruculosa* (aka *Chloromorum toxicum)* and *Chattonella subsalsa* are two species that can produce brevetoxins (causes Neurotoxic Shellfish Poisoning). Brevetoxin is also produced by *Karenia brevis*, a species associated with FL red tides, fish kills/sea mammal deaths. Exposure to brevetoxins can cause itchy skin, runny nose, watery eyes, and respiratory irritation akin to an asthma attack. *C.* cf *verruculosa* has been associated with large fish kills in other areas, and was implicated in a fish kill event in DE during 2000. No evidence of toxic activity in MD.

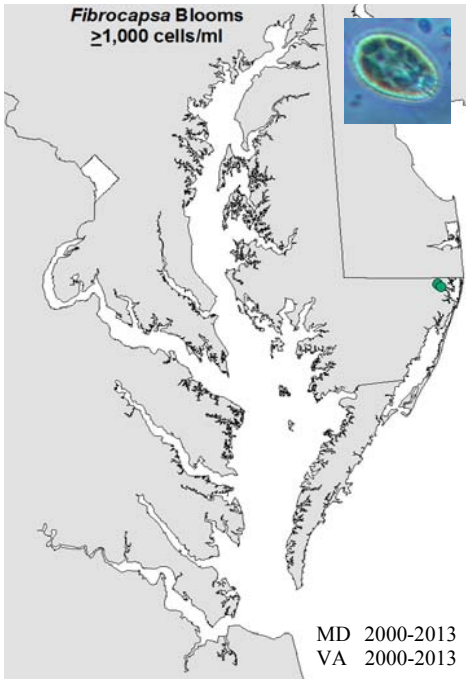
Fibrocapsa

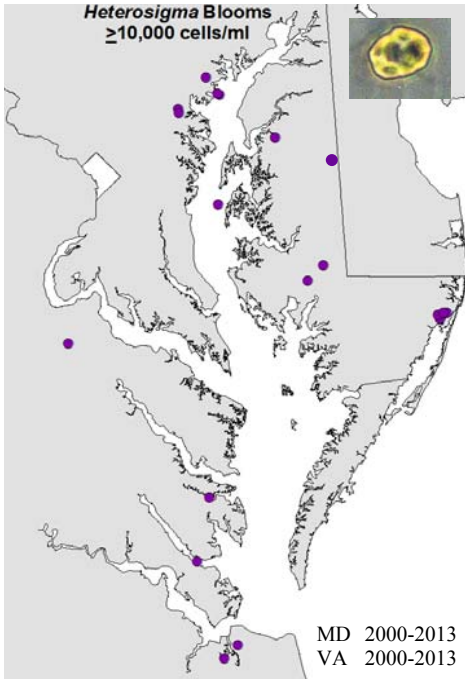
Fibrocapsa has had devastating impacts on mariculture operations in Japan. Strains of *F. japonica* from the North Sea in Europe have been capable of producing a toxin that killed fish in laboratory studies. Two seals that died in the Wadden Sea in Germany were found to have high levels of the toxin fibrocapsin. North Sea strains of *F. japonica* grow well at 11-25°C, 20-30 salinity. While found in the Chesapeake Bay region, it has never bloomed there. Blooms have been found in the Maryland coastal bays.

Heterosigma akashiwo

Heterosigma is more wide spread. *H. akashiwo* is found on both coasts of the US and is considered the causative organism in offshore fish farm kills in Washington state and Japan. Blooms prefer warmer temperatures (>15 °C) and moderate salinity (~15). Blooms can persist as long as stable water stratification persists in the warmer months. An unidentified ichthyotoxin (fish killing toxin) and reactive oxygen species (ROS) have been suggested as the causative agent in mariculture fish kills. No documented effects to humans.







Macroalgae in the Coastal Bays and *Lyngbya*

Macroalgal Blooms

Dense accumulations of macroalgae (seaweed) have been observed in the DE and MD coastal bays as well as some areas in the Chesapeake Bay. They can lead to substantial shading of underwater grasses and low dissolved oxygen events through nocturnal respiration and/or decomposition. Largely ungrazed, these blooms can also impede recreational boating. Brown algae (pheophytes) are not a dominant type but red and green are abundant. Large and chlorophyll-rich, these algae should be detectable with remote sensing, if they remain in the euphotic zone.

Rhodophytes, Red Algae

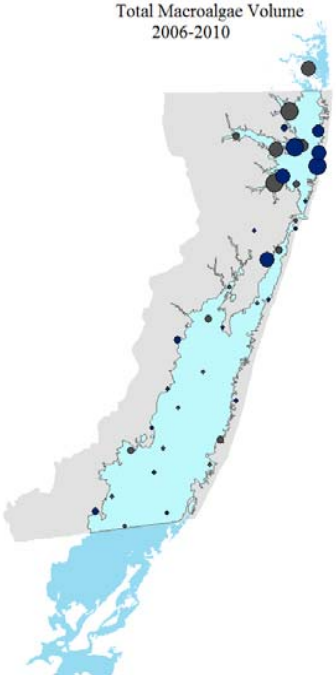
The Agarh's Red Weed (*Agardhiella tenera*) is the dominant species in the MD coastal bays with Graceful Red Weed (*Garcilaria sp.*) second. These two genera are the most characteristic plants in warm bays and sounds south of Cape Cod. Red algae are commercially raised and harvested for their agar and carrageenans which are used in the food, cosmetic, and medical industry. *Gracilaria tikvahiae* is often found in areas undergoing eutrophication.

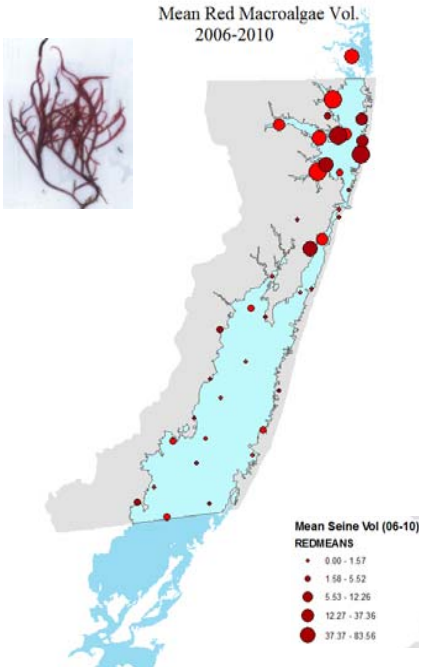
Chlorophytes, Green algae

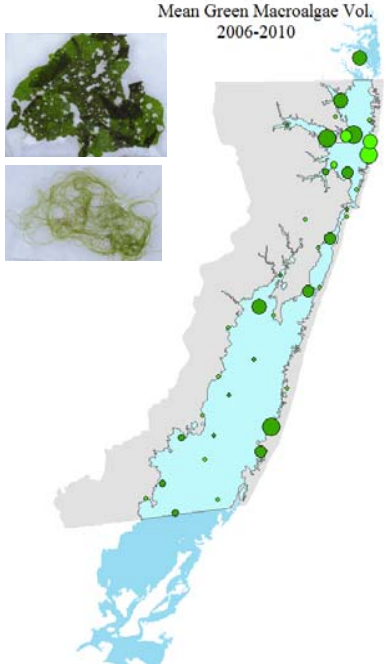
Green Hair Algae (*Chaetomoropha sp.*) and Sea Lettuce (*Ulva*) were the most abundant green macroalgae. *Ulva* was widespread throughout the coastal bays and present during all seasons. *Ulva* spp. have been associated with eutrophication. The state of Delaware found *Ulva* to be so abundant that they initiated a harvesting program to reduce the threat to habitat, through depleted dissolved oxygen. *Ulva* is initially attached, but in later stages of life is free drifting.

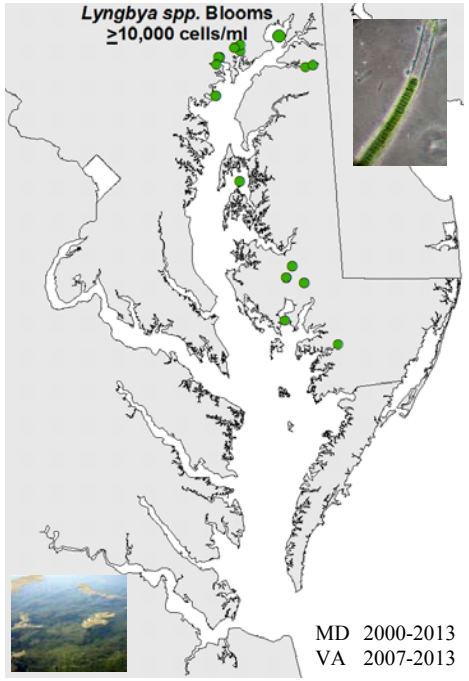
Lyngbya spp.

Lyngbya is a benthic, filamentous cyanobacteria. The wool-like strands often clump together and rise to the surface forming large floating mats. Found in lakes, rivers, springs, and water supply reservoirs throughout southeastern US, it is capable of forming thick nuisance blooms during the summer months under optimal growing conditions (24°C and favourable light). It is a problem in Florida where toxins cause skin and gastrointestinal inflammation. In the northern bay it has fouled crab pots an fishing gear, and covered seagrass beds.









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